

Amendments to the Claims:

The following listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Original) A positioning data calculating procedure for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the sixth link and the object turn, a rotation axis about which the fifth and the sixth link turn and a rotation axis about which the fourth and the fifth link turn intersect each other at a triaxial intersection point, said positioning data calculating procedure comprising:

a data entering step of entering data on position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a triaxial intersection point coordinate calculating step of calculating x-, y- and z-coordinate of the triaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object;

a first-to-third rotation angle calculating step of calculating first to third rotation angles by solving coordinate expressions including an x-coordinate expression representing the x-coordinate of the triaxial intersection point, a yz addition coordinate expression representing the sum of the y- and the z-coordinate of the triaxial intersection point, and a yz subtraction coordinate expression representing the remainder of subtraction of the z-coordinate from the y-coordinate of the triaxial intersection point, and including a first

rotation angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second rotation angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third rotation angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables; and

a fourth-to-sixth angle calculating step of calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, a fifth rotation angle through which the sixth link is turned relative to the fifth link, and a sixth rotation angle through which the object is turned relative to the sixth link on the basis of the first to the third rotation angle and the orientation of the object.

2. (Original) A rotation angle calculating procedure for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the fifth and the sixth link turn, and a rotation axis about which the fourth and the fifth link turn intersect each other at a biaxial intersection point, said rotation angle calculating procedure comprising:

a data entering step of entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a biaxial intersection point coordinate calculating step of calculating x-, y- and z-coordinate of the biaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object;

a first-to-third angle calculating step of calculating first to third angles by solving coordinate expressions including an x-coordinate expression representing the x-coordinate of the biaxial intersection point, a yz addition coordinate expression representing the sum of the y- and the z-coordinate of the biaxial intersection point, and a yz subtraction coordinate expression representing the remainder of subtraction of the z-coordinate from the y-coordinate of the biaxial intersection point, and including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables; and

a fourth-and-fifth angle calculating step of calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, and a fifth rotation angle through which the sixth link is turned relative to the fifth link, on the basis of the first to the third rotation angle and the orientation of the object.

3. (Original) A positioning data calculating apparatus for calculating relative rotation angles of first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the sixth link and the object turn, a rotation axis about which the fifth and the sixth link turn and

a rotation axis about which the fourth and the fifth link turn intersect each other at a triaxial intersection point, said positioning data calculating apparatus comprising:

a data entering means for entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a calculating means for calculating an x-, a y- and z-coordinate of the triaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object, determining first to third rotation angles by solving coordinate expressions including an x-coordinate expression representing the x-coordinate of the triaxial intersection point, a yz addition coordinate expression representing the sum of the y- and the z-coordinate of the triaxial intersection point, and a yz subtraction coordinate expression representing the remainder of subtraction of the z-coordinate from the y-coordinate of the triaxial intersection point, and including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables, and calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, a fifth rotation angle through which the sixth link is turned relative to the fifth link, and a sixth rotation angle through which the object is turned relative to the sixth link on the basis of the first to the third rotation angle and the orientation of the object; and

an output means for providing calculated data calculated by the calculating means.

4. (Original) A positioning data calculating apparatus for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated

manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the fifth link and the sixth link turn, and a rotation axis about which the fourth and the fifth link turn intersect each other at a biaxial intersection point, said positioning data calculating apparatus comprising:

a data entering means for entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a calculating means for calculating x-, y- and z-coordinate of the biaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object, determining first to third rotation angles by solving coordinate expressions including an x-coordinate expression representing the x-coordinate of the biaxial intersection point, a yz addition coordinate expression representing the sum of the y- and the z-coordinate of the biaxial intersection point, and a yz subtraction coordinate expression representing the remainder of subtraction of the z-coordinate from the y-coordinate of the biaxial intersection point, and including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables, and calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, and a fifth rotation angle through

which the sixth link is turned relative to the fifth link on the basis of the first to the third rotation angle and the orientation of the object; and

an output means for providing calculated data calculated by the calculating means.

5. (Original) An articulated manipulator comprising:

first to sixth links arranged in series;

coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes; and

diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes;

wherein the sixth link is attached rotatably to a predetermined object so that the object is able to turn about the axis of the sixth link, the fifth and the sixth link are connected by the diagonal joint, the fourth and the fifth link are connected by the coaxial joint, the third and the fourth link are connected by the diagonal joint, the second and the third link are connected by the coaxial joint, and the first and the second link are connected by the diagonal joint.

6. (Original) An articulated manipulator comprising:

first to sixth links arranged in series;

coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes; and

diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes;

wherein the sixth link is fixedly connected to a predetermined object, the fifth and the sixth link are connected by the diagonal joint, the fourth and the fifth link are connected by the coaxial joint, the third and the fourth link are connected by the diagonal

joint, the second and the third link are connected by the coaxial joint, and the first and the second link are connected by the diagonal joint.

7. (New) A positioning data calculating procedure for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the sixth link and the object turn, a rotation axis about which the fifth and the sixth link turn and a rotation axis about which the fourth and the fifth link turn intersect each other at a triaxial intersection point, said positioning data calculating procedure comprising:

a data entering step of entering data on position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a triaxial intersection point coordinate calculating step of calculating x-, y- and z-coordinate of the triaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object;

a first-to-third rotation angle calculating step of calculating first to third rotation angles including a first rotation angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second rotation angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third rotation angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables; and

a fourth-to-sixth angle calculating step of calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, a fifth rotation angle through which the sixth link is turned relative to the fifth link, and a sixth rotation angle through which the object is turned relative to the sixth link on the basis of the first to the third rotation angle and the orientation of the object.

8. (New) A rotation angle calculating procedure for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the fifth and the sixth link turn, and a rotation axis about which the fourth and the fifth link turn intersect each other at a biaxial intersection point, said rotation angle calculating procedure comprising:

a data entering step of entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a biaxial intersection point coordinate calculating step of calculating x-, y- and z-coordinate of the biaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object.

a first-to-third angle calculating step of calculating first to third angles including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third angle corresponding to a

rotation angle through which the fourth link is turned relative to the third link as variables;
and

a fourth-and-fifth angle calculating step of calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, and a fifth rotation angle through which the sixth link is turned relative to the fifth link, on the basis of the first to the third rotation angle and the orientation of the object.

9. (New) A positioning data calculating apparatus for calculating relative rotation angles of first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the sixth link and the object turn, a rotation axis about which the fifth and the sixth link turn and a rotation axis about which the fourth and the fifth link turn intersect each other at a triaxial intersection point, said positioning data calculating apparatus comprising:

a data entering means for entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a calculating means for calculating an x-, a y- and z-coordinate of the triaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object, determining first to third rotation angles including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned relative to the second link, and a third angle corresponding to a rotation angle through which

the fourth link is turned relative to the third link as variables, and calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, a fifth rotation angle through which the sixth link is turned relative to the fifth link, and a sixth rotation angle through which the object is turned relative to the sixth link on the basis of the first to the third rotation angle and the orientation of the object; and

an output means for providing calculated data calculated by the calculating means.

10. (New) A positioning data calculating apparatus for calculating relative rotation angles for first to sixth links arranged in series and included in an articulated manipulator including coaxial joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to turn about a rotation axis aligned with their axes, and diagonal joints each connecting the adjacent ones of the first to the sixth link so that the adjacent links are able to revolve about a rotation axis inclined to their axes, in which the sixth link is attached rotatably to a predetermined object, and a rotation axis about which the fifth link and the sixth link turn, and a rotation axis about which the fourth link and the fifth link turn, intersect each other at a biaxial intersection point, said positioning data calculating apparatus comprising:

a data entering means for entering data on a position and orientation of the object in a reference coordinate system with an x-axis, a y-axis and a z-axis orthogonally intersecting each other and fixed relative to the first link;

a calculating means for calculating x-, y- and z-coordinate of the biaxial intersection point in the reference coordinate system on the basis of the entered data on the position and orientation of the object, determining first to third rotation angles including a first angle corresponding to a rotation angle through which the second link is turned relative to the first link, a second angle corresponding to a rotation angle through which the third link is turned

relative to the second link, and a third angle corresponding to a rotation angle through which the fourth link is turned relative to the third link as variables, and calculating a fourth rotation angle through which the fifth link is turned relative to the fourth link, and a fifth rotation angle through which the sixth link is turned relative to the fifth link on the basis of the first to the third rotation angle and the orientation of the object; and

an output means for providing calculated data calculated by the calculating means.